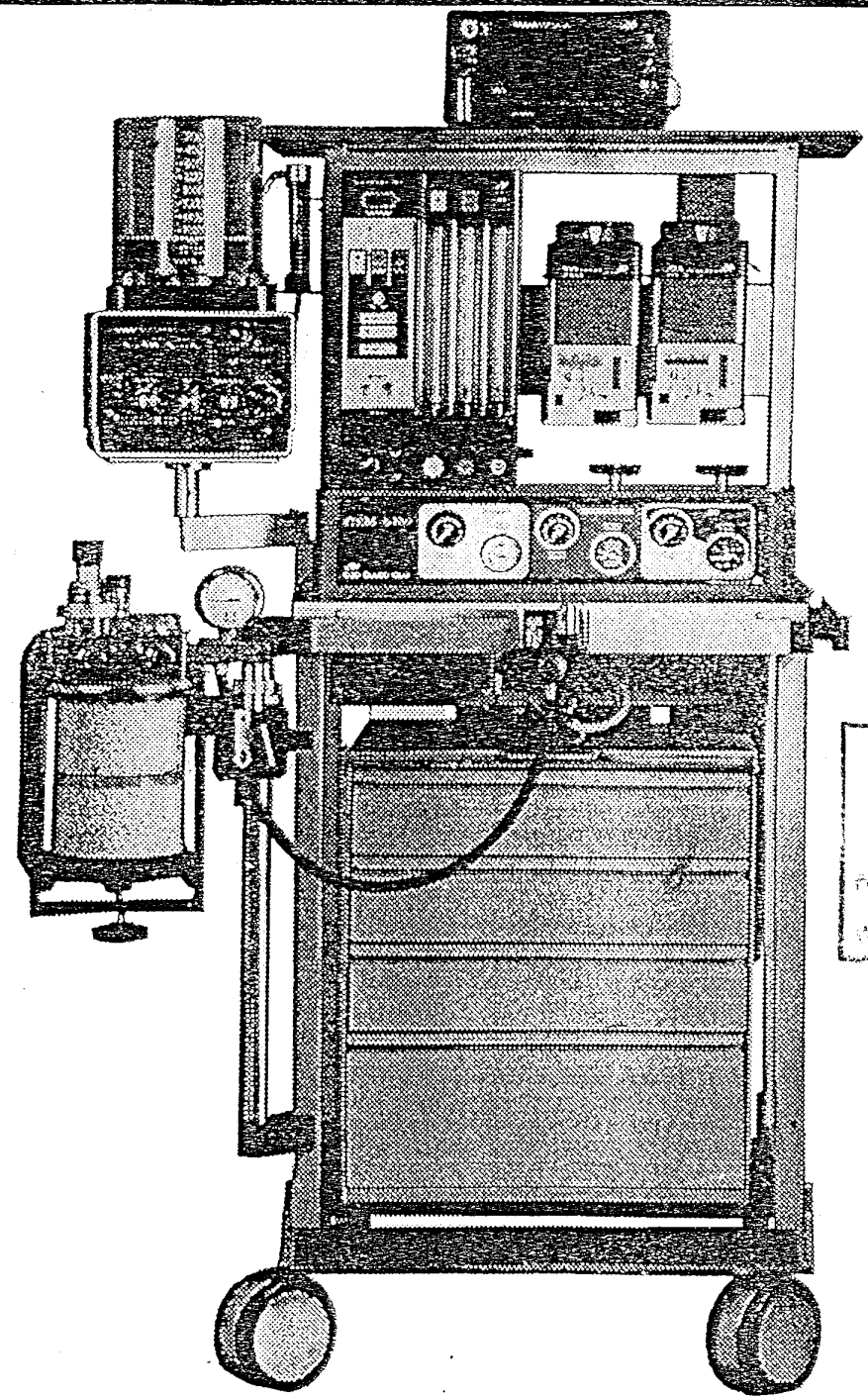
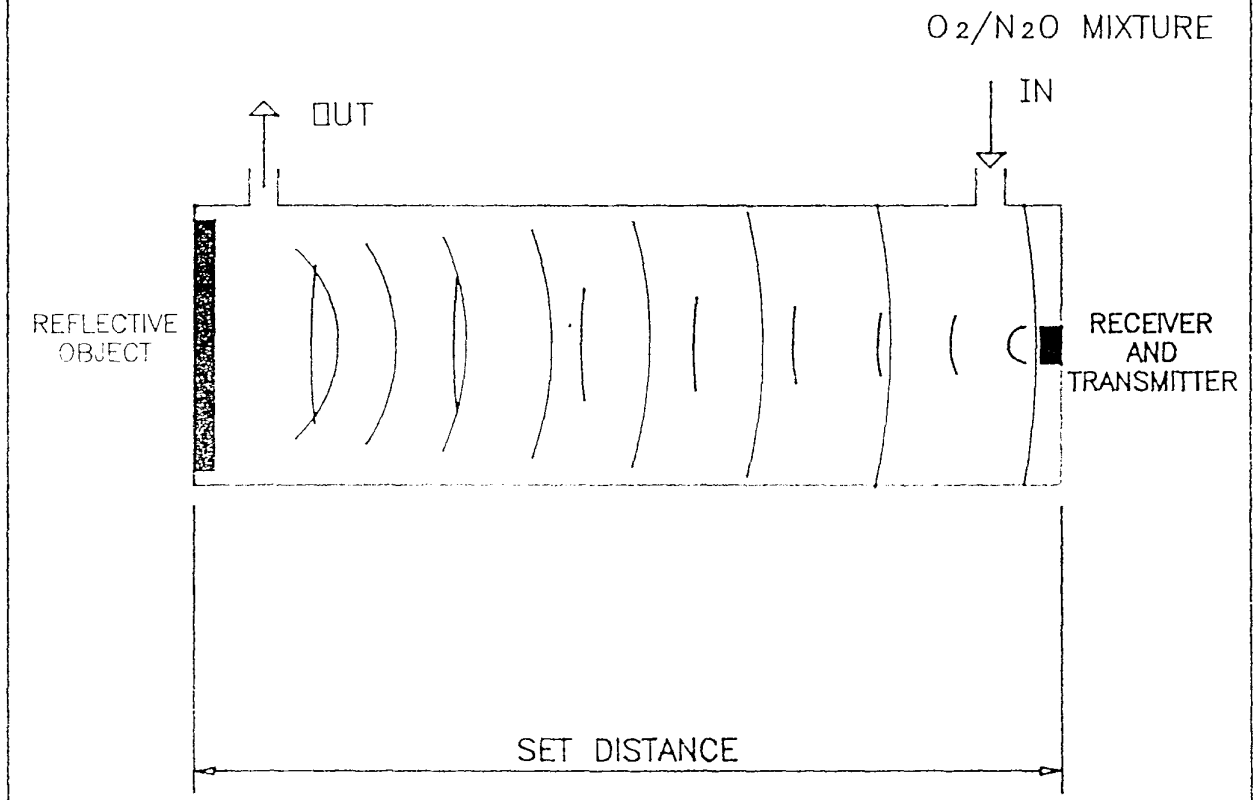
GEM 9100 Anaesthesia Machine

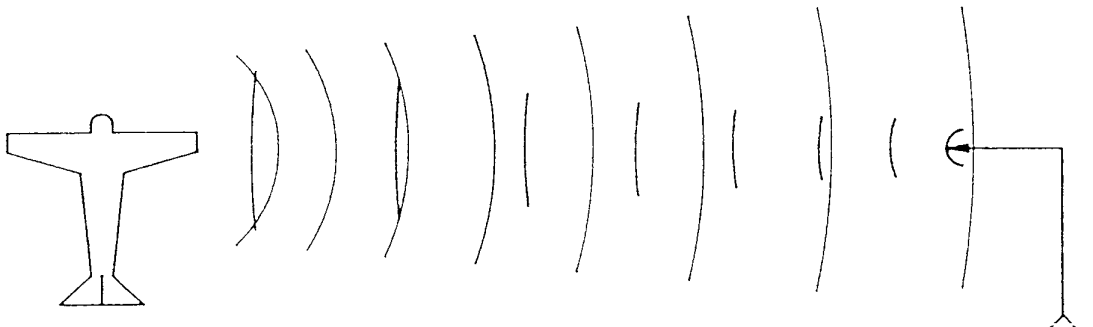


Service Manual

ULTRASOUND CELL

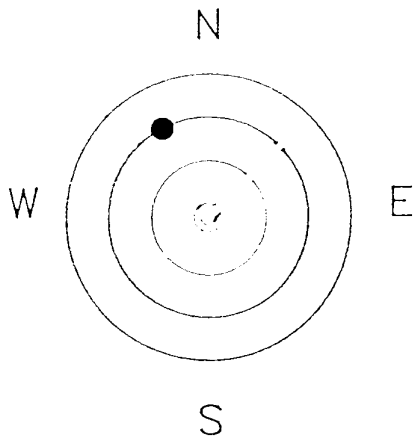


RADAR



AIR

TRANSMITTER
RECEIVER



• GMS 125 (cont'd)

1. Gas analysis--same principle as that of radar

-show slide of radar

-show slide of chamber

- structure of the chamber and
- ultrasonic transducer--
  transmiter(speaker)/receiver(micro phone)
- every 500ms, transmits a shor burst of pulses (49.1 KHz, last 1ms) into the chamber
- transmiter reverts to receiver to detect the echo returning after reflection from the opposite end.
- time for the pulse travel to & return from the other end is an accurate indication of the velocity of sound in the gas mixture in the chamber
- velocity of sound varies with the molecular density of a gas and can be used to determine the percentage of O2 in a mixture with one other (known) gas

E. GMS125 Alarm Chart

Alarm Condition	Visible Indication	Audible Tones	Mute Time	Other Actions
Software Alarms				
No Air when Air selected	AIR FAIL	Low/High	30 Sec.	----
No N_2O when N_2O selected	N_2O FAIL	Low/High	30 Sec.	----
Oxygen Supply Failure	O_2 FAIL	High/Low/High	15 Sec.	N_2O Shut Off
% Reading Outside Expected Range	SYSTEM ERROR Blank Display	High/Low	30 Sec (EF3)	----
Air ON when not selected	SYSTEM ERROR	High/Low	30 Sec. (EF1)	----
N_2O ON when not selected	SYSTEM ERROR	High/Low	30 Sec. (EF2)	----
N_2O & Air simultaneously selected	SYSTEM ERROR	High/Low	30 Sec. (EF4)	----
Battery volts less than 11.8 volts	LOW BATTERY	High/Low	Continuous	----
% less than 23 in N_2O	LOW OXYGEN	High/Low/High	15 Sec.	----
% less than 18 for 5 Seconds	As above	As above	As Above	N_2O Shut Off
% over 19 for 15 Seconds				N_2O Turn On
Hardware Alarms				
Microcomputer Failure	Random	Continuous Tone	No Mute	----
Failure of Both Mains and Battery	No Lights	Continuous Whistle Powered by Oxygen	No Mute	----
Mains Off	MAINS OFF Light Blinks	Brief Tone	No Mute	----

6. Procedures

6.1. Service Procedures

A. General

1. Calibrate and perform Preventative Maintenance on the GEM 9100 Anaesthesia System in accordance with the schedule listed below.
2. Request that the system is cleaned and cleared of all non-related drugs, phials etc. and that all contaminated patient circuits are removed before the system is presented for service procedures.
3. Check and record the system Serial No. and determine which procedure, either a three month, six month, twelve month or thirty-six month calibration, test or service is required.

Warning: **Before disconnecting any gas supply tube or electrical lead ensure that it incorporates an identification sleeve and, if necessary, fit an additional temporary identification to facilitate correct reconnection. Remove the temporary identification when the reconnection is completed. Failing to reconnect a supply tube or an electrical connection correctly can cause an incorrect gas delivery and possibly patient injury.**

B. Service Procedures

1. Close all gas cylinder outlets, disconnect all pipeline gas supply hoses at both inlet and outlet connections.
2. Release all residual gas from the system, disconnect all breathing tubes, accessory equipment and electrical supply plugs.
3. Remove Tec Vaporisers, check exchange dates and inspect all vaporisers for mechanical damage.
4. Remove all cylinders, remove work surface.

6.2. Pipeline Gas Hose

Inspect for correct colour coding and sleeve indexing.

6.3. Frame and Castors

1. Inspect the top shelf, for condition and security of attachment.
2. Inspect the work surface support for condition and security of attachment.
3. Inspect all components within the work surface compartment for condition and security of attachment.

4. Inspect the absorber mounting post assembly for condition and for vertical and lateral adjustment.

5. Inspect the drawer unit for condition and security of attachment, ensure that each drawer opens and closes freely.
6. Inspect the castor legs for condition and security of attachment, two screws on each leg, and inspect the plastic buffers for condition and security of attachment.
7. Lift the brake to the OFF condition and check that all four castors rotate and pivot freely. Depress the brake to the ON condition and check that neither of the two front castors can either rotate or pivot in any direction.
8. Inspect and tighten multerail and attachments.

6.4. Gas Supply System

Caution: **Service only one gas supply system at a time, commencing with the right hand oxygen system viewed from the rear in order to minimise the possibility of components from two or more gas supply systems being interchanged.**

1. Fully tighten and then fully unscrew the cylinder yoke wing screw to check for freedom of movement. Apply a smear of approved Vac Kote lubricant to the screw threads if required and clean off any surplus lubricant.
2. Inspect the cylinder index pins for condition and security. If any pin is loose or damaged, fit a new system cylinder yoke.
3. Remove and discard the cylinder gasket (Bodok seal) from the cylinder inlet fitting.

6.5. Gas Supply System - Testing & Calibration

A. High Pressure Leak Test

1. Set the On/Off Switch to ON.
2. Verify all pipeline supplies are disconnected.
3. Open oxygen cylinder.
4. Close oxygen cylinder.
5. Gauge reading should not visibly drop in one minute.
6. Turn the On/Off switch to the On position. Open the oxygen flow control valve to relieve high pressure.
7. Close all flow control valves.
8. Turn the On/Off switch to the Off position.
9. Reconnect the oxygen pipeline supply.
10. Turn the On/Off switch to the On position.
11. Open N_2O cylinder.
12. Close N_2O cylinder.

13. Gauge reading should not visually drop in one minutes.
14. Open N_2O flow control valve to relieve high pressure.
15. Open air cylinder.
16. Select Air.
17. Close Air cylinder.
18. Gauge reading should not visually drop in one minute.
19. Open Air flow control valve to relieve high pressure.
20. Turn On/Off switch to OFF.
21. If there is a high pressure leak:
    a. With any cylinder: check for a damaged cylinder gasket, a loose tee handle, a stuck pressure relief valve and leaking test point.
    b. With an Oxygen cylinder: also check for leakage through the O_2 power outlet, flush valve and auxiliary connector.
22. Repeat steps 2 through 21 for each cylinder.
23. Reconnect pipeline supplies.

Note: GMS 125 Monitor or ventilator alarms may sound during the test.

B. Gas Supply Block Dynamic and Static Output Test

Note: Remove the top tray from the machine

1. Fit a full cylinder to the gas supply block under test, ensure that cylinder valve is closed and the gas test control unit fitted with a bleed block and the control valve is fully closed.
2. Remove test point plug at regulator test point. Fit a test tube at regulator test point and connect it to pressure meter. Open cylinder valve and gas test control valve and check that the gas supply system dynamic pressure conforms with the dynamic pressures provided as follows:

Gas	Static Pressures	Dynamic Pressures
Oxygen	320 kPa +/- 5%	Greater than 250 kPa
Nitrous Oxide	320 kPa +/- 5%	Greater than 250 kPa
Air	320 kPa +/- 5%	Greater than 250 kPa

3. Close the gas test control valve and check that the regulator static pressure conforms with the static pressures provided above.
4. If the pressures do not conform, adjust the regulators.
5. Turn the adjustment screw clock wise to increase the pressure or counter-clockwise to decrease the pressure as required.

6. If the regulator cannot be adjusted to the correct pressure, carry out repairs on the regulator or fit a new unit.
7. Repeat the tests described for all other gas systems.
8. When the tests is satisfactorily completed, close the cylinder valve and then open the gas test control valve to release any pressure and disconnect the test tube from the test point.

6.6. Oxygen System Leak Test

1. Disconnect inlet tube to rotameter and connect it to the gas test unit.
2. Fully open the O_2 cylinder valve.
3. Switch On/Off to On.
4. Pressure should stabilise at nominal 320 kPa ± 5%.
5. Turn off cylinder then bleed pressure at ventilator outlet.
6. Pressure stabilises, 1 minute test, less than 10 kPa drop.
7. This indicates V8 does not leak.

6.7. ON/OFF Rotary Switch

Note: Ensure reserve O_2 pressure is depleted before carrying out this test.

1. Connect as per 6.6.1 to 6.6.2.
2. No pressure should register on the gas test unit.
3. Switch On/Off to On.
4. Gas test unit reads O_2 regulator pressure.

6.8. PS1 Pressure Test

1. Connect as per 6.6.1 to 6.6.4.
2. Close cylinder valve.
3. Slowly bleed system pressure at gas test unit control valve.
4. Note pressure when O_2 fail condition occurs at 207 kPa +- 5% nominal.

6.9. Reserve O_2 Regulator Pressure Test

1. Connect as per 6.6.1 to 6.6.4.
2. Close cylinder valve.
3. Slowly bleed O_2 Pressure from gas test unit Control Valve.
4. Note when pressure stabilises, it should reads 175 kPa +- 5%.
5. Adjust Norgren regulator if necessary and repeat Steps 1-4.

6.10. N_2O System Leak Test

1. Disconnect inlet tube to rotameter and connect it to the gas test unit.
2. Ensure O_2 supply fitted, On/Off switch is ON and N_2O is selected.
3. Open N_2O cylinder valve.
4. When gas test unit reading stabilises, close cylinder valve.
5. Select Air.
6. Pressure stabilises, 1 minute test, less than 10 kPa drop.
7. This indicates V9 does not leak.

6.11. PS2 Pressure Test

1. Disconnect inlet tube to N_2O rotameter and connect it to the gas test unit.
2. Fully open O_2 and N_2O cylinder valves.
3. Switch On/Off to ON.
4. Pressure should stabilise at 320 kPa nominal.
5. Turn off N_2O cylinder valve then bleed pressure at gas test unit control valve.
6. Note pressure when N_2O fail condition occurs at 200 kPa +/- 5% nominal.

6.12. Vaporiser Manifold Mechanical Checks

1. Inspect the manifold assembly for signs of mechanical damage and security of attachment.
2. Check the port valve cartridges for damage and security of attachment and fit new vaporiser sealing 'O' rings.
3. Check that port valves are securely in place and not loose.
4. Check the plungers for free movement between fully open to fully closed.

6.13. Pressure Relief Valve Setting Check

1. Connect a pressure manometer to the fresh gas outlet.
2. Set the O_2 flow to 0.1 Lpm.
3. Block the outlet of the manometer and check that the pressure rises to 40cm H_2O within 30 seconds.
4. Allow the pressure to increase and check that the safety valve operates between 45 and 55cm H_2O.
5. Replace or repair safety valve if safety valve does not relieve at 60 cmH_2O.

6.14. Oxygen Flush Valve Test

1. Connect a respirometer to the fresh gas outlet
2. Press the oxygen flush button and check that the flow from the oxygen flush outlet indicated on the respirometer is greater than 35 Lpm.
3. If a flow of between 35 and 55 Lpm cannot be achieved, fit a new Schraeder valve in the common gas outlet block.

6.15. Low Pressure Leak Test

1. Fully close all flow control valves.
2. Attach the test device to the Fresh Gas Outlet. To help ensure accurate readings the test device flowtube must be positioned vertically.
3. Fully open the test device needle valve.

Caution: **Failure to perform this step could damage the test device pressure gauge.**

4. Remove all vaporisers from the vaporiser manifold.
5. Set the ON/OFF switch to ON.
6. Select O_2 and set the flow to 0.4 Lpm of gas through the test device flowmeter. Confirm that the test device pressure gauge remains near zero and that all other flow control valves are fully closed.
7. Close the test device needle valve until a pressure of 3 kPa is indicated and maintained on the test device pressure gauge.
8. Record the flow shown on the test device flowmeter. When tested under these described conditions, the flow shall not drop below 0.35 Lpm.
9. Fit one vaporiser at a time and repeat the low pressure leak test with each vaporiser switched both OFF, ON and set to 1%.
10. When tested under these described conditions, the flow shall not drop below 0.35 Lpm.

Warning: **After performing the low pressure leak test, do not use the anaesthesia system until the system has been purged with O_2. Using a system that has not been purged with oxygen may result in incorrect gas mixtures and injury to the patient.**

6.16. Port Valve Servicing

Note: Complete disassembly and service of a Port Valve should not be under taken. Repair it by replacing the Port Valve only.

Port valve Renewal - 512355

1. Remove the manifold rear panel.
2. Disconnect connection pipes at the bottom face of the valve.
3. Remove 'O' ring and two fixing screws on top face of manifold.
4. Remove valve assembly.
5. Renewal - fit the Port Valve in reverse order to removal.

Caution: **Correct steps must be followed to ensure no cross connection.**

Note: When replacing connecting pillars, re-seal thread with 'Loctite' Hydraulic seal. Care should be taken to remove loose particles that may have been left by previous assembly to prevent leaks and blockages. When the pipes are re-connected ensure that none of the pipes are kinked. The pipes should be positioned so that they do not pass immediately behind any of the brackets fixing points.

6. Refit rear panel.
7. Carry out Low Pressure Leak Test in section 6.14.

6.17. Low Oxygen Monitor Test

1. Connect as per diagram.

2. Select N_2O and set flows as per Table 1 below and ensure O_2 Analyser and monitor readings are as shown.

TABLE 1					
Flowtubes (LPM)		Monitor		O_2 Analyser	
O_2	N_2O	Min	Max	Min	Max
2.0	8.0	18	22	18	22
4.0	4.0	49	52	48	52
8.0	2.0	78	82	78	82
8.0	1.5	89	93	89	93
8.0	0.5	92	96	93	96
8.0	0.0	98	100	98	100

3. Select Air and repeat step 2 using table 2.

TABLE 2					
Flowtubes (LPM)		Monitor		O_2 Analyser	
O_2	Air	Min	Max	Min	Max
0.0	10.0	19	23	19	23
0.5	9.5	24	28	24	28
2.0	8.0	35	39	35	39
4.0	4.0	58	62	58	62
8.0	2.0	83	87	83	87

6.18. Air System Leak Test

1. Disconnect inlet tube to rotameter and connect it to gas test unit.
2. Ensure O_2 supply fitted, On/Off is ON and Air is selected.
3. Open Air cylinder valve.
4. When gas test unit reading stabilises, close cylinder valve.
5. Select N_2O.
6. Pressure stabilises, 1 minute test, less than 10 kPa drop.
7. This indicates V10 does not leak.

6.19. PS3 Pressure Test

Note: Reinstall the top tray.

1. Connect as per 6.6.1 to 6.6.4.
2. Close cylinder valve.
3. Slowly bleed system pressure at gas test unit control valve.
4. Note pressure when Air fail condition occurs at 200 kPa +-5% nominal.

6.20. O_2 Failure Operational Check

1. Connect for normal operation and select N_2O.
2. Set O_2 and N_2O rotameter at 4 Lpm.
3. Close O_2 cylinder valve.
4. When O_2 fail occurs ensure:
   a. N_2O supply ceases.
   b. N_2O and O_2 rotameter back lights extinguish.
   c. O_2 supply continues at about 2 Lpm.
5. Restore O_2 supply.
6. System returns to normal operation.
7. Select Air.
8. Repeat steps 2 to 6 substituting Air for N_2O. (except Air rotameter does not cut off).

6.21. AC & DC Power Failure Test

1. Connect for normal operation.
2. Disconnect battery + ve terminal.
3. Disconnect AC power supply.
4. An audible gas operated alarm must be heard.

6.22. GMS125 Test Procedure

1. Configure for normal operation of GEM.
2. Supply O_2 and N_2O.
3. On/Off to ON.
4. All 7 LEDs illuminate and P.O.S.T. preformed.
5. O_2 monitor reads current O_2 percentage.
6. Select Air - Air fail
   - N_2O & Air back lights OFF.

- Press mute- 30 seconds timeout.

7. Turn ON Air supply - Air fail OFF.
   - Air back light ON.
8. Select N_2O - N_2O back light ON.
9. N_2O supply OFF.
10. Bleed N_2O ensuring O_2 monitor keeps above 25%
    - N_2O fail.
    - N_2O back light OFF.
11. N_2O supply ON.
12. O_2 supply OFF.
13. Bleed O_2 - O_2 fail.
    - O_2 and N_2O back lights OFF.
14. O_2 supply ON.
15. Set O_2 flow at 0.5 Lpm and N_2O at 2 Lpm.
    - Monitor reads 20% +/- 2%.
    - Low O_2 alarm at 23% and audible sound should be heard.
16. Increase N_2O flow to 3 Lpm.
    - N_2O cut OFF 5 seconds after monitor passes 18%.
    - Low O_2 alarm ceases as monitor rises above 26%.
    - N_2O restored 15 seconds after monitor rises above 19%.
17. System restored to normal operation.

6.23. Electrical Safety

1. Inspect power lead and GPO's for damage.
2. Ensure all 6 GPOs and power pack On/Off LEDs illuminate when AC supplied.
3. Perform electrical safety tests as per AS3551.

6.24. Perform Pre-operative Checkout and System Shutdown

GEM 9100 PNEUMATIC CIRCUIT DIAGRAM